Southwest Regional Partnership on Carbon Sequestration

Phase I Project Overview

DE-PS26-O3NT41983

October 12, 2005

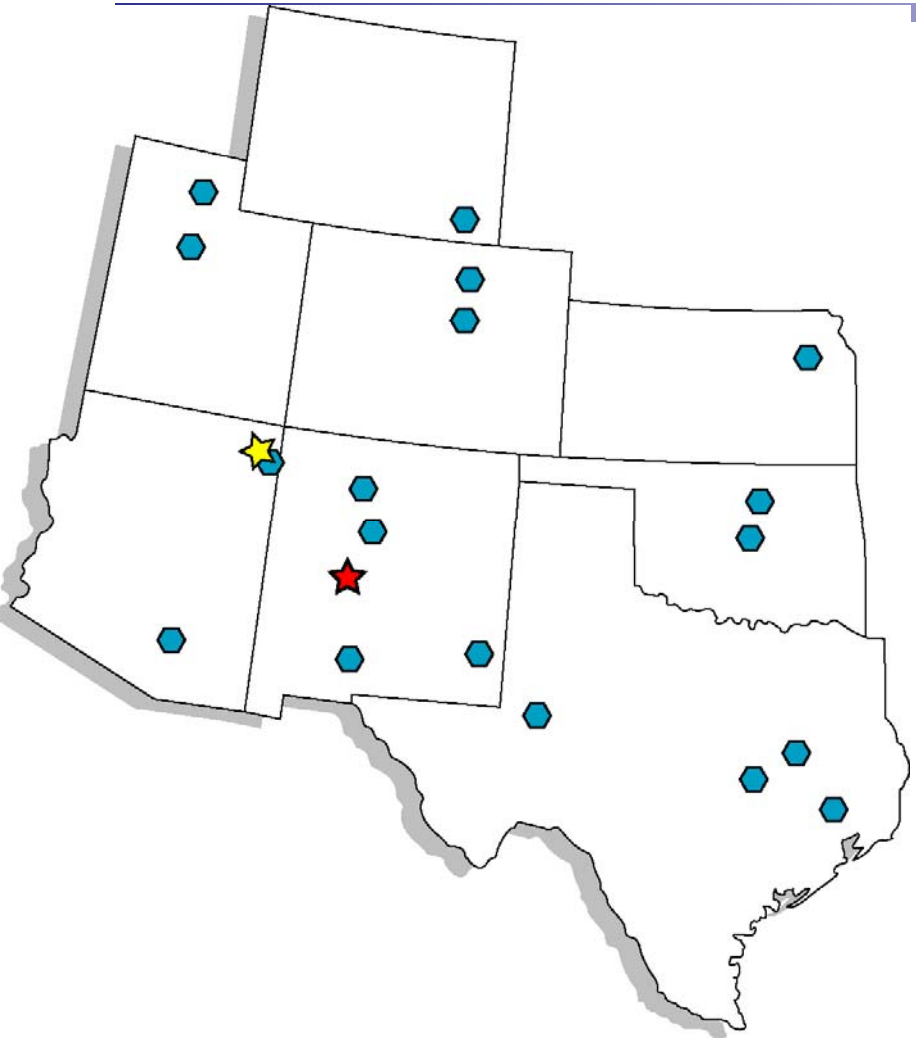
NETL Regional Carbon Sequestration Partnerships Review Meeting

Pittsburgh, Pennsylvania

Outline

- **Briefest Overview of Region and Partners**
- **Public Outreach and Education**
- **Characterization of Region:**
  - Geologic
  - Terrestrial
  - Emissions and Capture
- **Linking Sources to Sinks: “String of Pearls”**
  - Integrated Assessment and Analysis

Partners



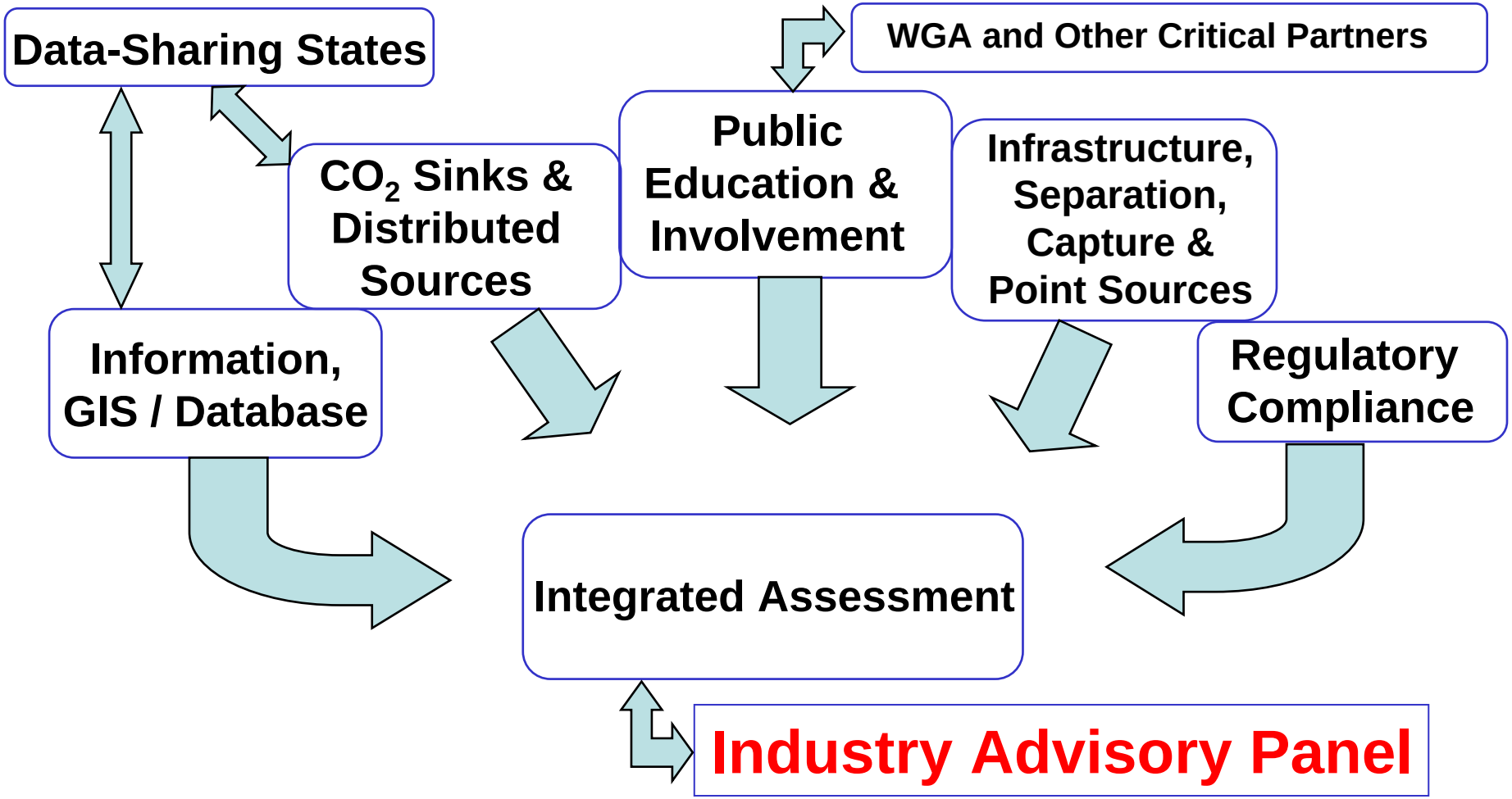
In all partner states:

- major universities
- geologic survey
- other state agencies

as well as

- Western Governors Association
- five major utilities
- seven energy companies
- three federal agencies
- the Navajo Nation
- many other critical partners

Working Groups



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Public Outreach and Education

- Goals & Objectives
- Strategies
- Tools
- Tools to Objectives
- Challenges for Phase II

Multiple Stakeholders

- Industry
- Environmental groups
- General public
- Governments
- Partnership members*

*much overlap with other groups

Goals

Identify—

current public opinion & knowledge about carbon sequestration.

Motivate—

public interest in carbon sequestration

Enable—

public to evaluate costs and benefits associated with carbon sequestration.

Objectives

1. Identify & respond to needs, fears, & desires.
2. Inform about requirements, science, strategies, & technologies.
3. Involve in discovery of opportunities.
4. Enable negotiation of mutual benefits.

Communication Strategies

- **Formal presentation**
  - **Inform (objective 2)**
- **Learning activities**
  - **Identify (objective 1)**
  - **Involve (objective 3)**
- **Process training**
  - **Enable (objective 4)**

Tools (Formal Presentation)

- Web site
- Printed information packet
- Talks by partnership experts

Tools (Learning activities)

- Electronic Town-hall meetings
- Mediated modeling workshops

Tools (Process training)

- **Mediated modeling workshops**

Tools → Objectives

Web site*
Printed information packet*
Talks by partnership experts*

***Inform**-political, scientific, technical aspects

Tools → Objectives

Electronic meetings

Inform-political, scientific, technical aspects*

*see formal presentations from technical experts

ID-stakeholder needs, fears, desires **

Involve-discover opportunities**

**synchronous conversations; stakeholders & researchers

Tools → Objectives

Modeling workshops

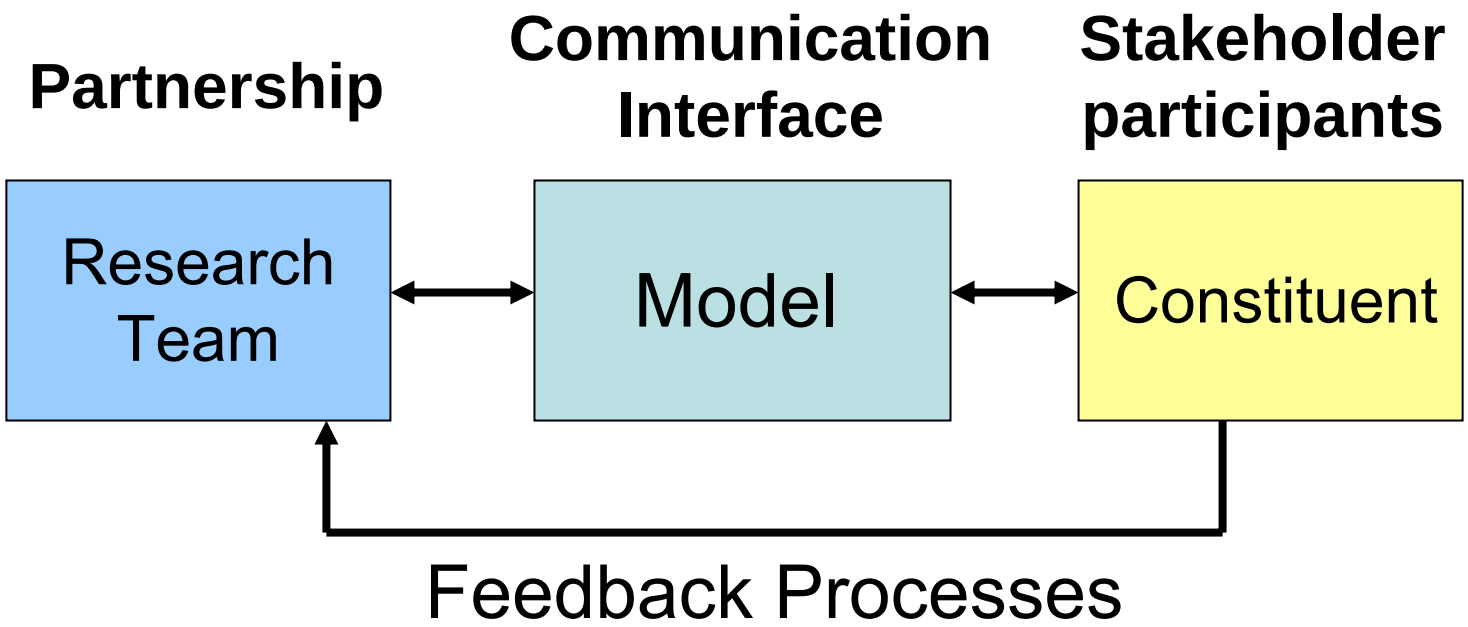
Involve: discover opportunities*

*synchronous conversation; stakeholders & researchers

Enable: negotiate benefits**

**develop communication skills, develop modeling skills, evaluate & revise multiple scenarios

Mediated Modeling Dialogue



Challenge for Phase II

- Need to engage all stakeholder groups
  - primary participants have been industry;
  - other stakeholders do not see immediate benefit;
  - interests of general public are site specific;
  - environmental groups fear negative publicity;
  - stakeholders lack sufficient time;
  - multiple jurisdictions and distance limit stakeholder participation.

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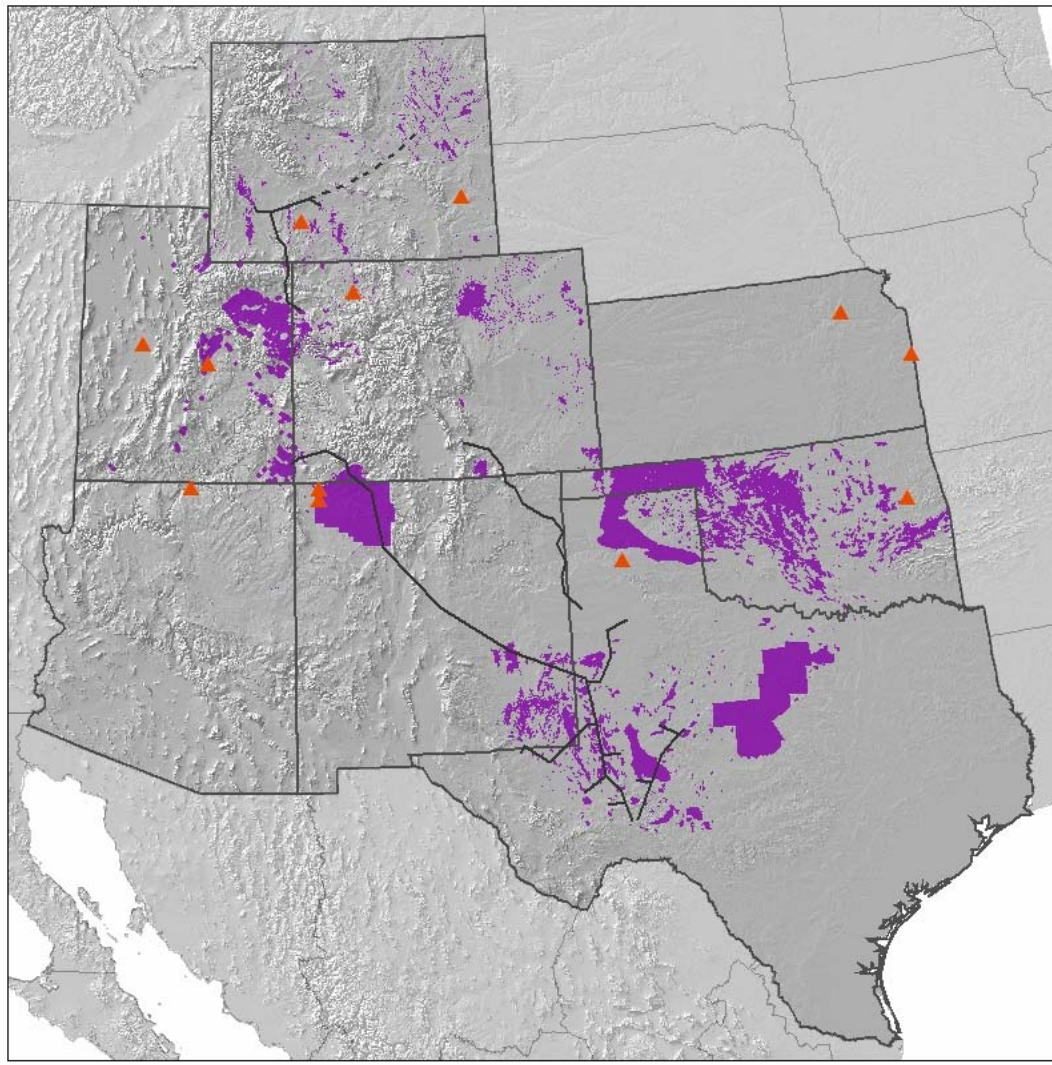
Southwest Region Oil/Gas Reservoir Sequestration Options

Note the proximity of potential oil/gas sequestration reservoirs to:
- Major CO_2 pipelines
- Major Power Plants

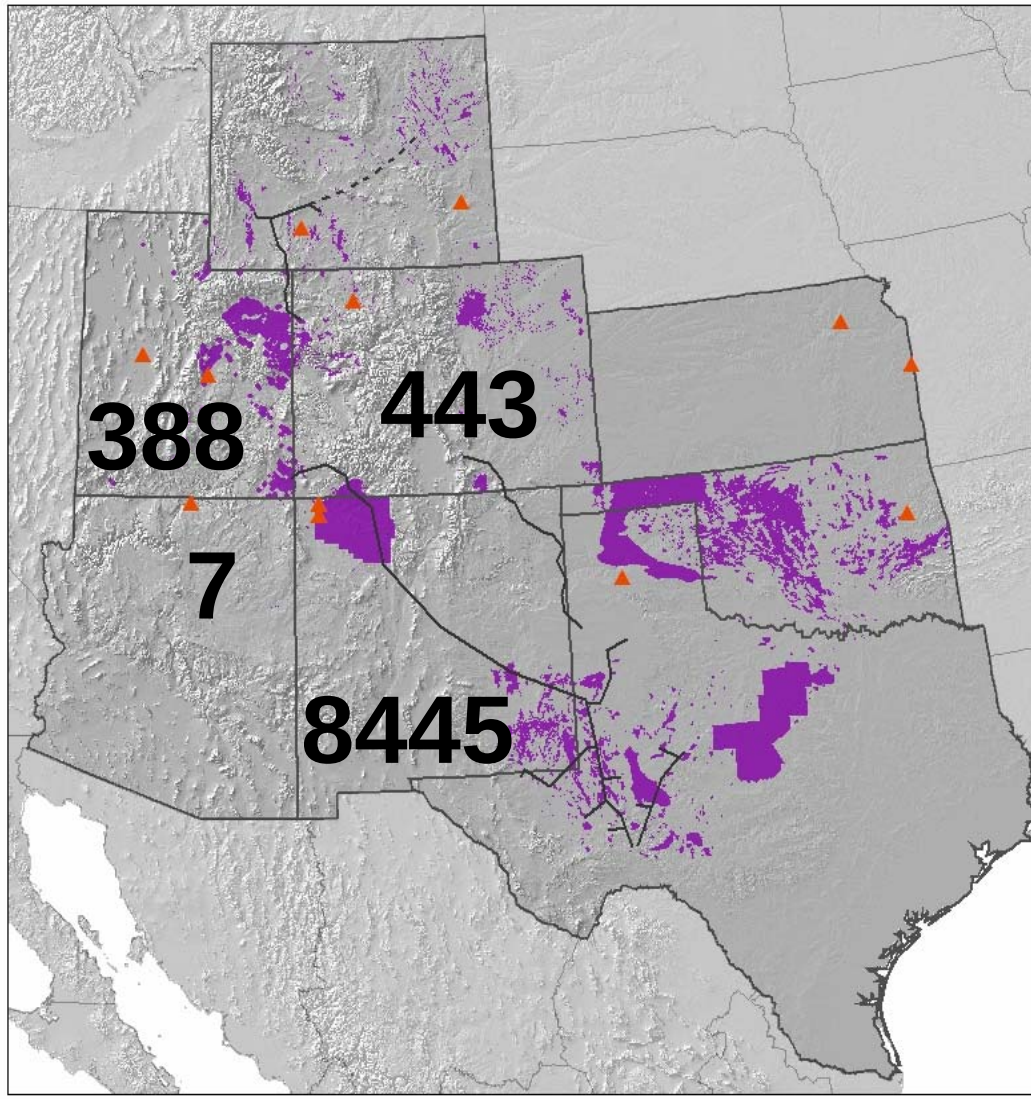
(power plants shown here are only those that emit more than 10 Mtons/year)



Southwest Region Oil/Gas Reservoir Sequestration Options

Illustrated here are estimated <u>minimum</u> CO_2 storage capacities (in million metric tons) for oil/gas options in each state

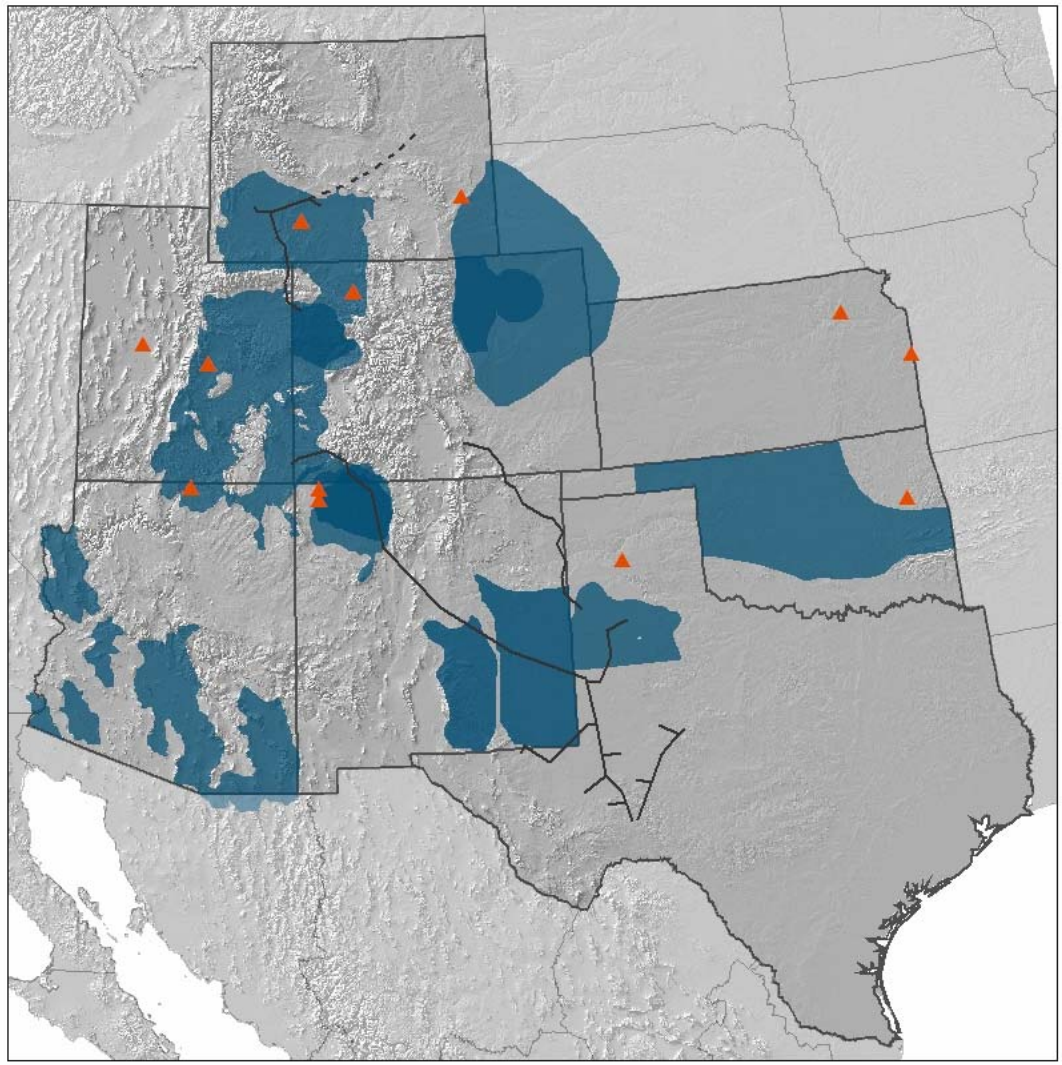
(excluding OK, TX, WY)



Major Saline Aquifer Options in the Southwest

Note the proximity of potential saline options to:
- Major CO_2 pipelines
- Major Power Plants

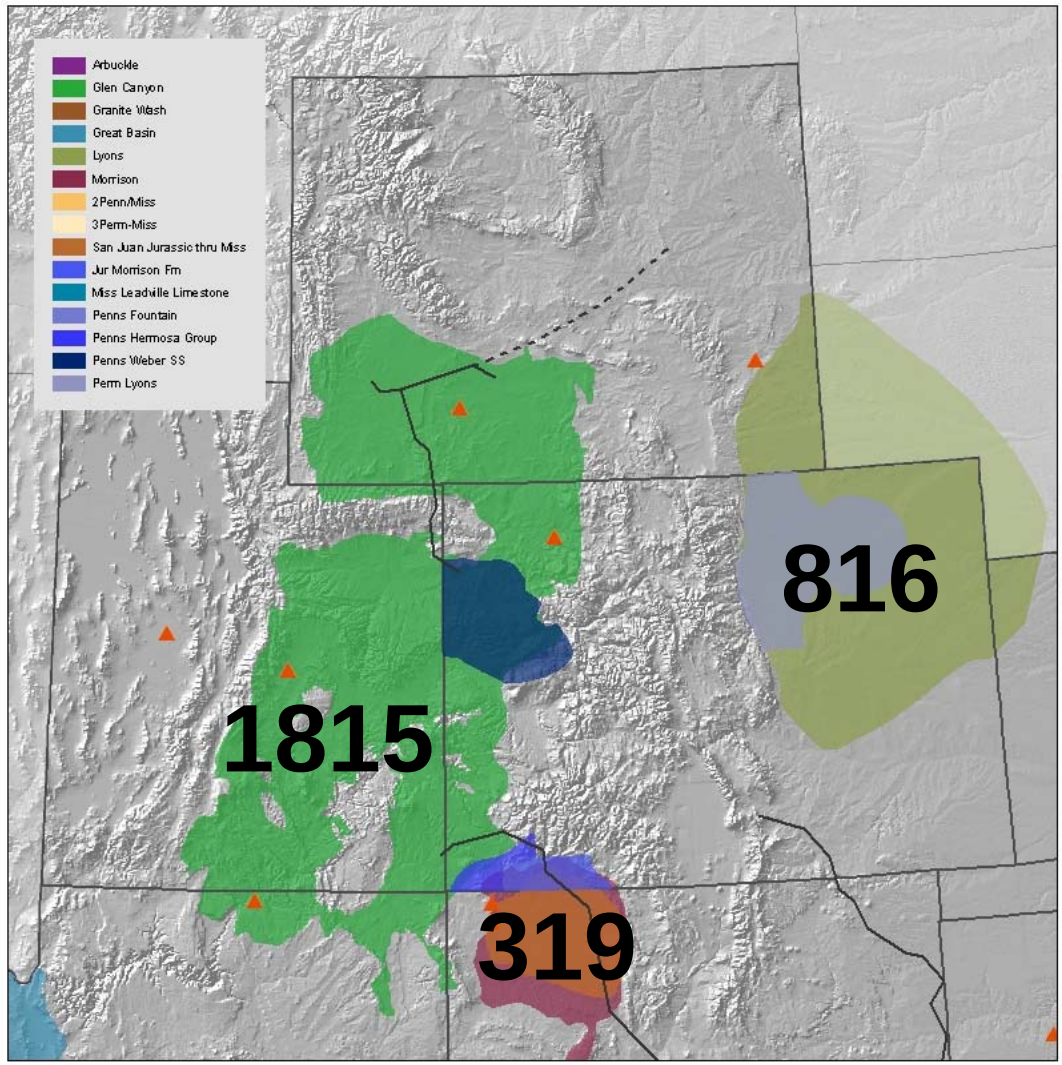
Data collected and assembled by:
- Southwest Partnership
- Texas BEG



Major Saline Aquifer Options in the Southwest

Shown here are estimated maximum capacities in billions of tons for saline options in the region.

(power plants shown here are only those that emit more than 10 Mtons/year)



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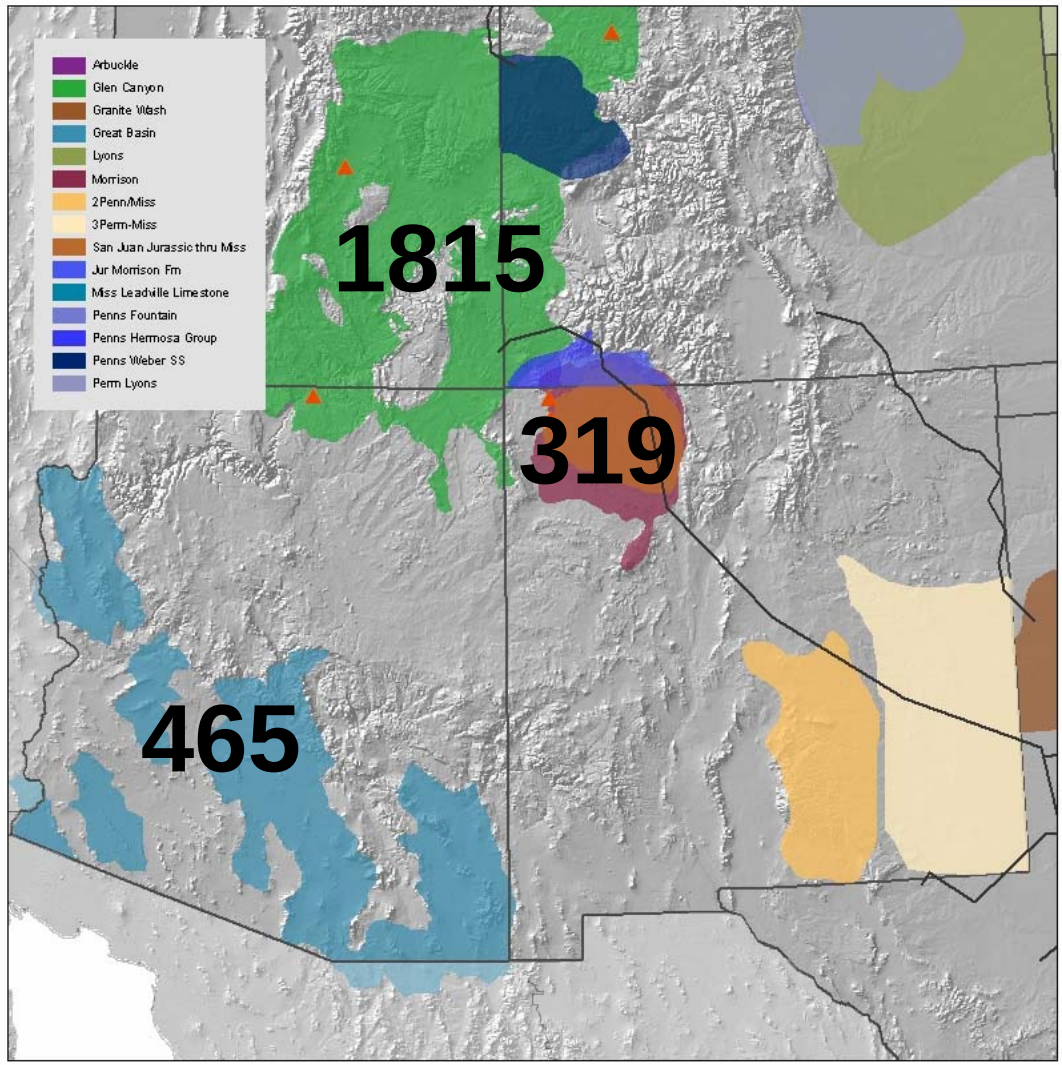

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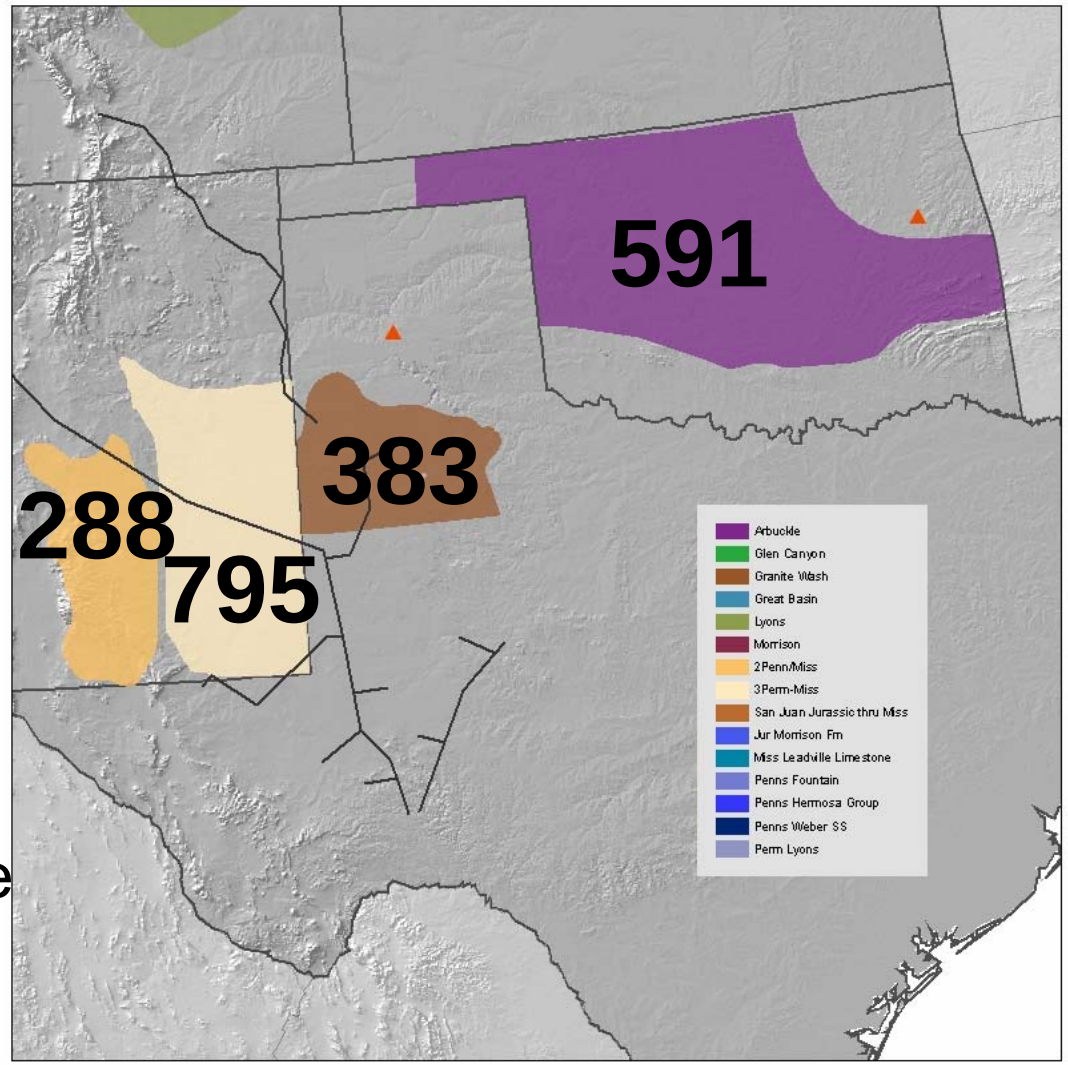
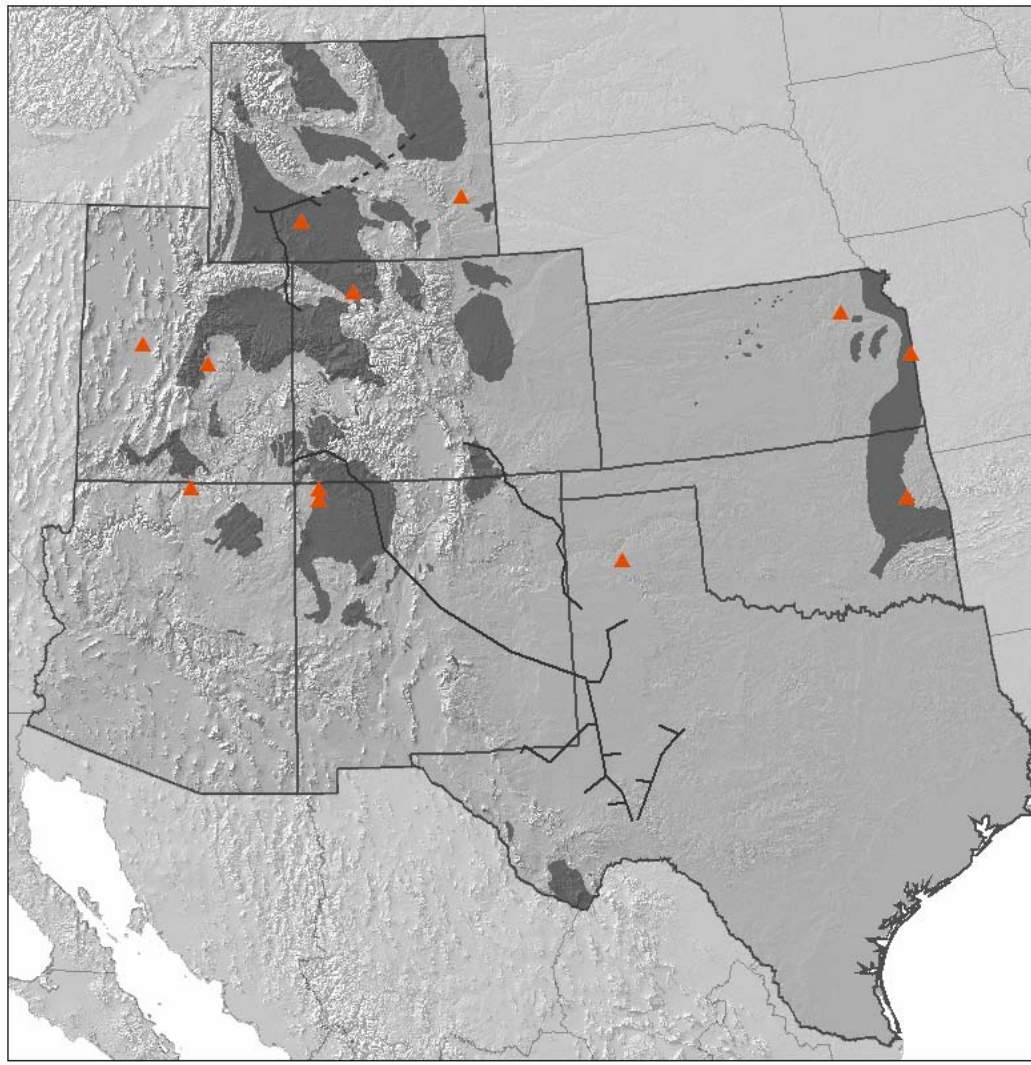


Major ECBM Options in the Southwest

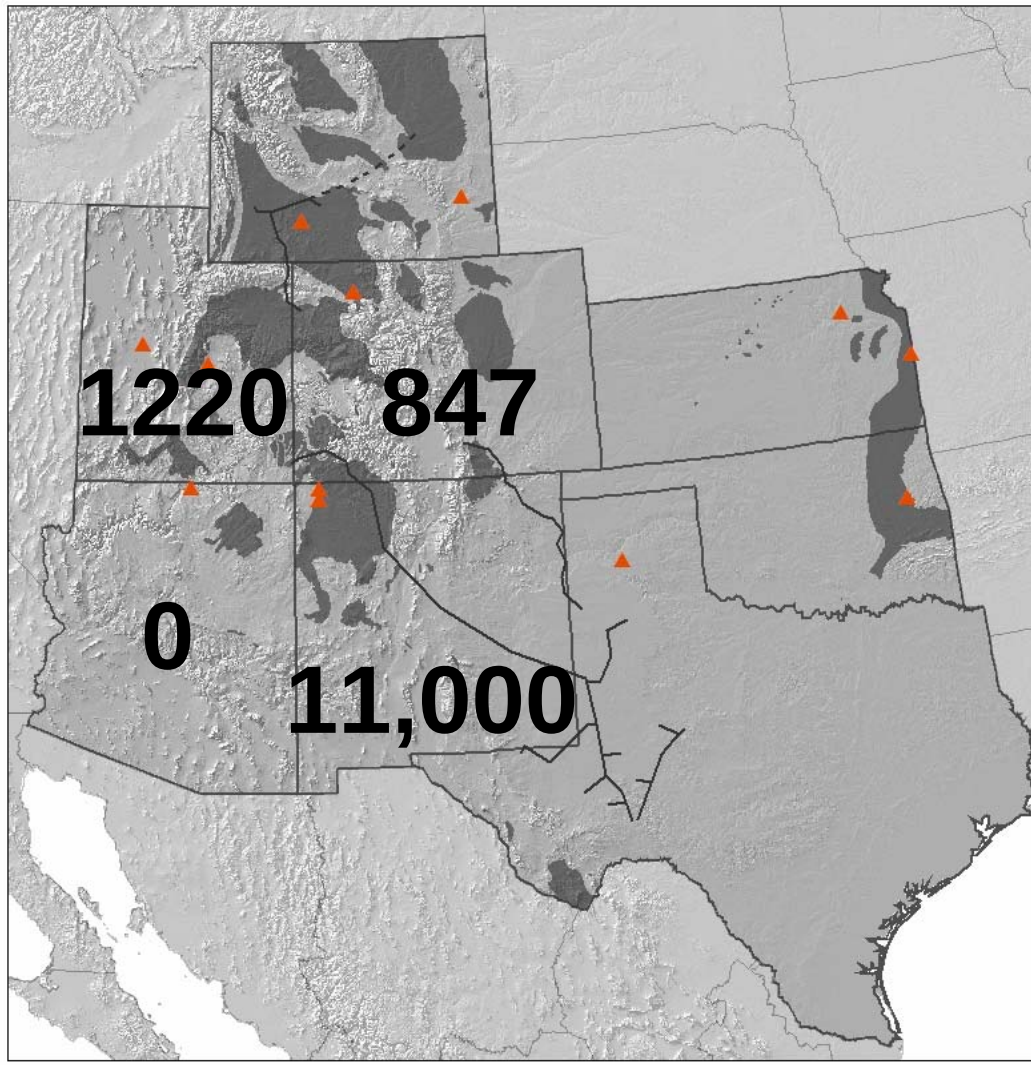
Note pipelines and major power plants (> 10 Mtons/year)



Major ECBM Options in the Southwest

Illustrated here are estimated CO_2 storage capacities (in million metric tons) for ECBM options in each state

(excluding OK, TX, WY)



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WHAT IS TERRESTRIAL CARBON SEQUESTRATION?

- Long-term storage of carbon in the soil or vegetation via naturally occurring processes of photosynthesis and plant growth (forests) and humification and aggregation (soils)

- Potential to increase soil carbon storage depends on:
  - precipitation
  - soil fertility
  - soil disturbance
  - land use history

- CENTURY Model

- exposing carbon compounds to the atmosphere releases CO_2 (tillage releases stored carbon)

WHAT IS TERRESTRIAL CARBON SEQUESTRATION?

Perhaps the most important point:

Sequestering carbon via addition of nutrients or water is reversed when inputs cease

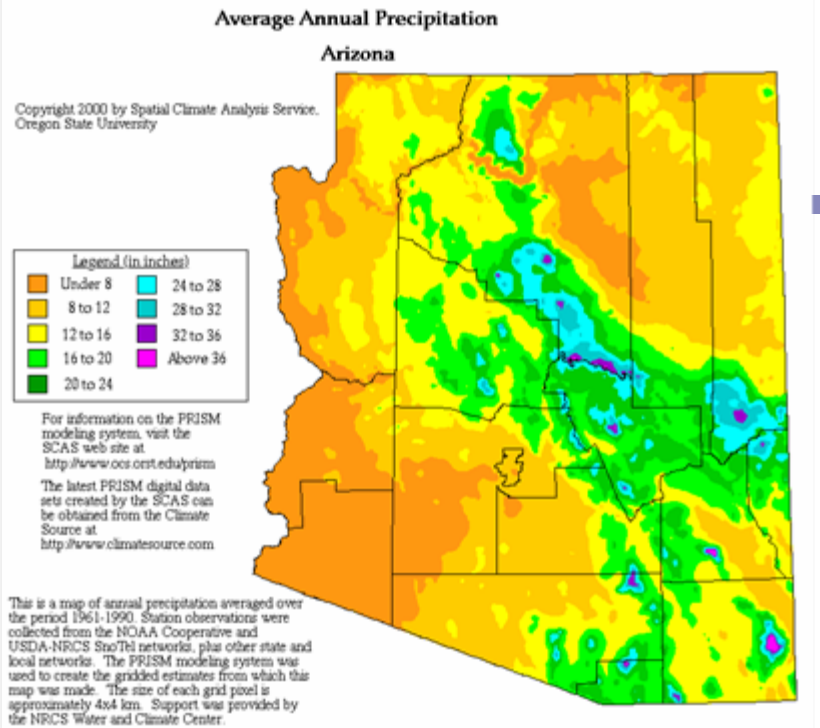
DEFINING THE POTENTIAL FOR CARBON SEQUESTRATION

- Yearly annual rainfall must exceed ~25 cm

- Irrigated vegetables not considered

- Forest land (USFS) is not considered; carbon sequestration is tracked by USFS, but land is not managed for carbon

- Results are presented at the state level



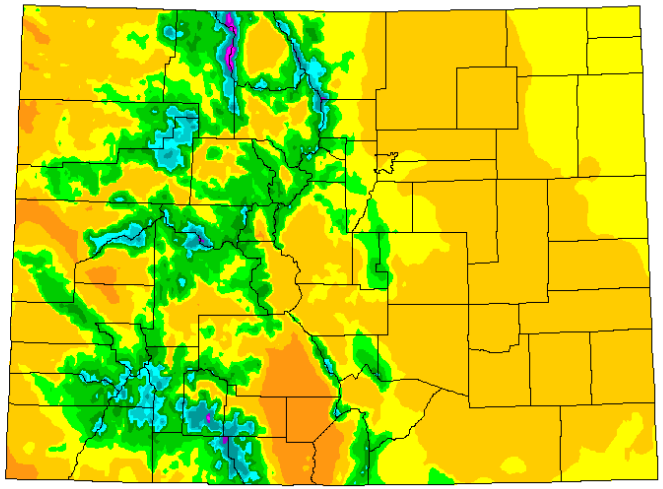
ARIZONA

12.2 Mha subjected to analysis

Predominant limitation is rainfall

Mha	CURRENT USE	FUTURE USE	C T/y ('000)
9.8	rangeland-light grazing	**CRP legume**	161.8
		light grazing	-4.8
1.2	rangeland-heavy grazing	CRP legume	464.9
		moderate grazing	30.1
		no change	29.5

COLORADO



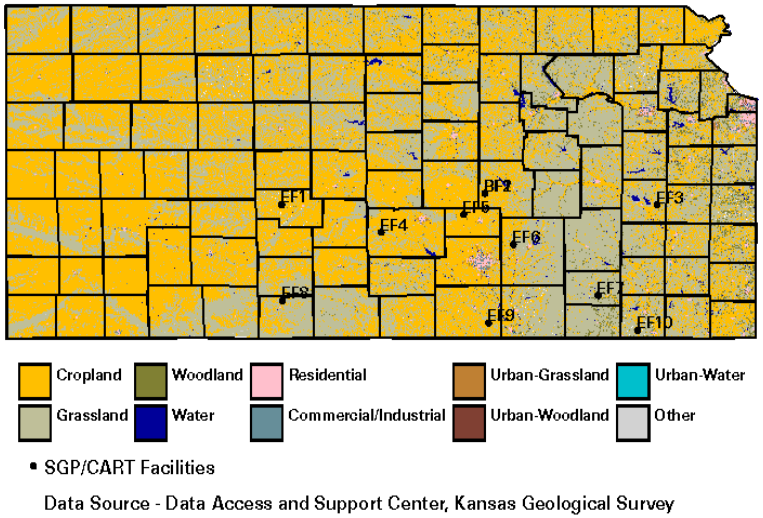
4.2 Mha analysis

Predominant limitation is high participation in CRP

Mha	CURRENT USE	FUTURE USE	C T/y ('000)
3.2	rangeland-grazing	legume addition	580
		light grazing	stable
0.98	small grains	CRP legume	934 (high rainfall as compared to AZ…)
		No-Till	20.5
		no change	stable

KANSAS

Kansas Landuse/Landcover



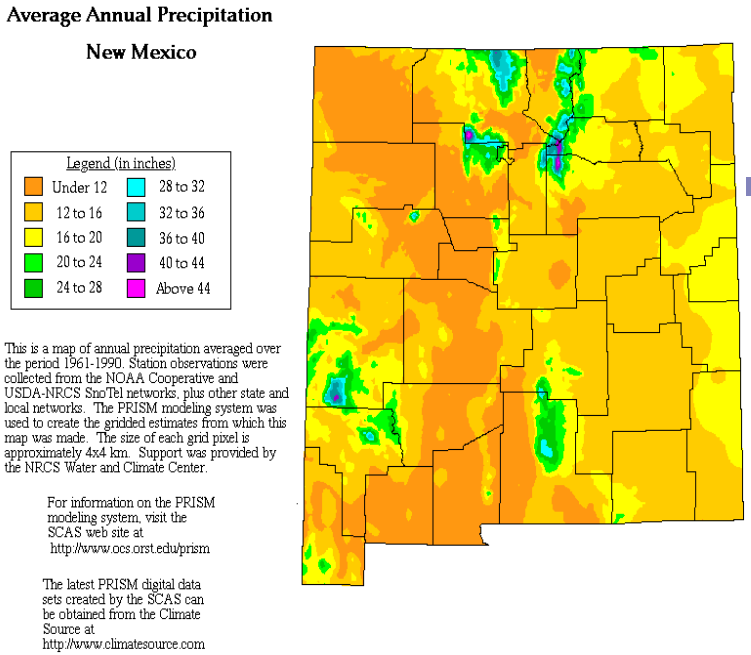
Data Source - Data Access and Support Center, Kansas Geological Survey

9.5 Mha analysis

Predominant limitation is high participation in CRP

Mha	CURRENT USE	FUTURE USE	C T/y ('000)
1.5	irrigated corn	CRP	1 495
		No Till (still grow corn, but tillage is minimized…)	724
3.5	small grains	CRP legume	4 685
		No-Till	106
		no change	stable
4.5	rangeland	CRP w/legume	829
		no change	stable

NEW MEXICO

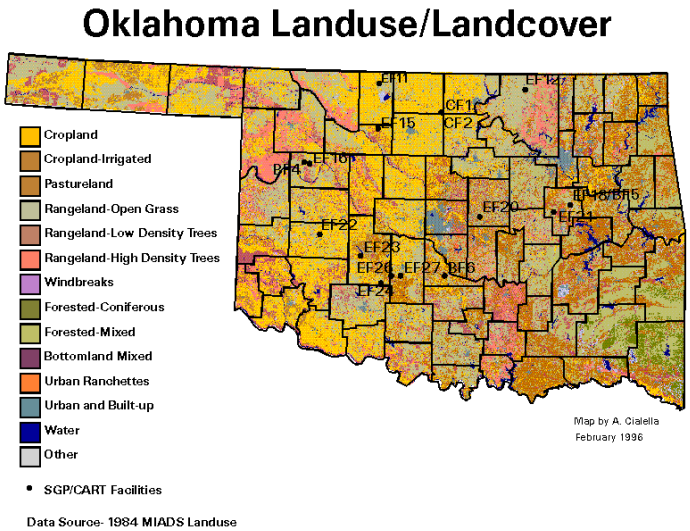


3.2 Mha analysis

Predominant limitation is high participation in CRP in eastern third and low precipitation in west

Mha	CURRENT USE	FUTURE USE	C T/y ('000)
.05	row crops	CRP	30.6
		No Till	16
.02	small grains	CRP legume	21.9
		No-Till	2.0
		no change	stable
3.1	rangeland	legume addition	282
		no change	stable

Western OKLAHOMA



2.1 Mha analysis

Predominant limitation is high participation in CRP (it's capped by percentage of land in CRP…) in eastern third and low precipitation in west

Mha	CURRENT USE	FUTURE USE	C T/y ('000)
.23	row crops (sorghum/corn)	CRP	252.9
		No Till	5.1
.72	small grains	CRP legume	772.9
		No-Till	86.7
		no change	stable
1.13	rangeland	legume addition	141
		no change	stable

Average Annual Precipitation

Utah

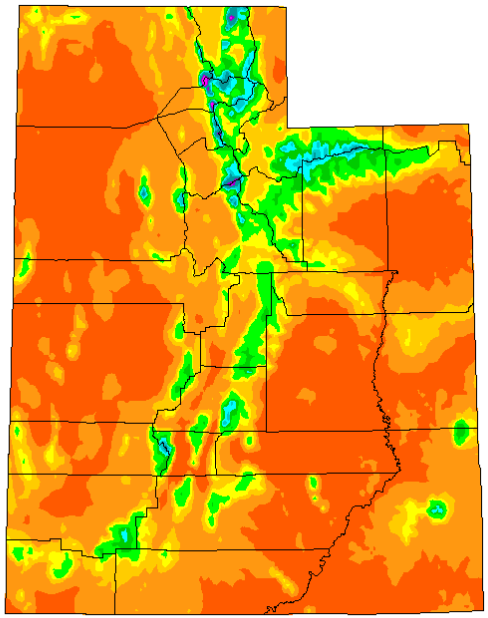
Legend (in inches)

Under 10	35 to 40
10 to 15	40 to 45
15 to 20	45 to 50
20 to 25	50 to 55
25 to 30	Above 55
30 to 35	

For information on the PRISM modeling system, visit the SCAS web site at http://www.ocs.orst.edu/prism

The latest PRISM digital data sets created by the SCAS can be obtained from the Climate Source at http://www.climatesource.com

This is a map of annual precipitation averaged over the period 1961-1990. Station observations were collected from the NOAA Cooperative and USDA-NRCS SnoTel networks, plus other state and local networks. The PRISM modeling system was used to create the gridded estimates from which this map was made. The size of each grid pixel is approximately 4x4 km. Support was provided by the NRCS Water and Climate Center.



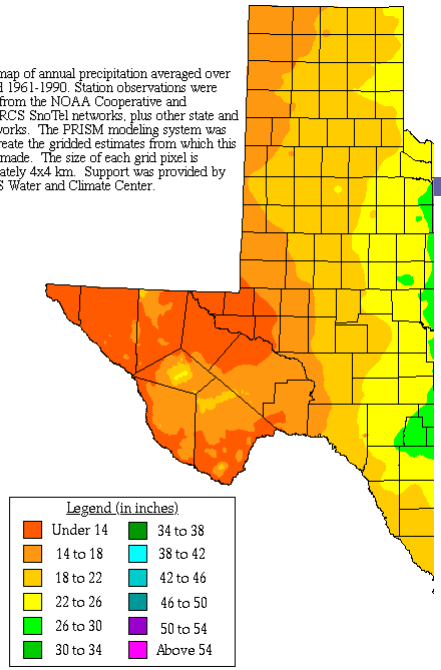
UTAH

1.9 Mha analysis

Predominant limitation is very low precipitation

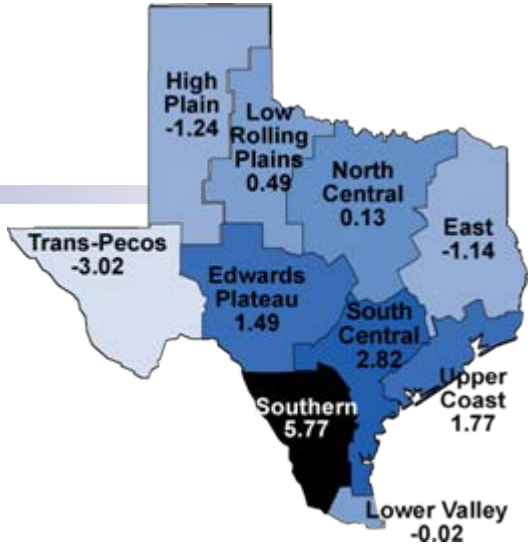
Mha	CURRENT USE	FUTURE USE	C T/y ('000)
1.9	rangeland	CRP legume addition	320
		improved management	.5

WEST TEXAS



5.2 Mha analysis

Predominant limitation is low precipitation



Palmer Drought Severity Index

-1 to -5 moderate to extreme

Mha	CURRENT USE	FUTURE USE	C T/y ('000)
1.8	row crops	CRP	1 811
		No Till	38.5
1.3	small grains	CRP legume	1 025
		No-Till	114.2
		no change	stable
2.1	rangeland	legume addition	203
		no change	stable

Southwest Region
TERRESTRIAL SEQUESTRATION POTENTIAL

~14 M T C/y high end
land conversion of cropland
legume addition on rangeland

~1.2 M T C/y low end
no land use change-tillage change only
no changes in rangeland management

Very high levels of participation in land retirement programs in the High Plains region may limit effectiveness

High levels of uncertainty associated with model outputs in areas outside the High Plains

Hot desert (Chihuahuan and Sonoran) land degradation may be losing C at ~ 1 T C/ha/y

Poorly developed technologies to restore rangeland

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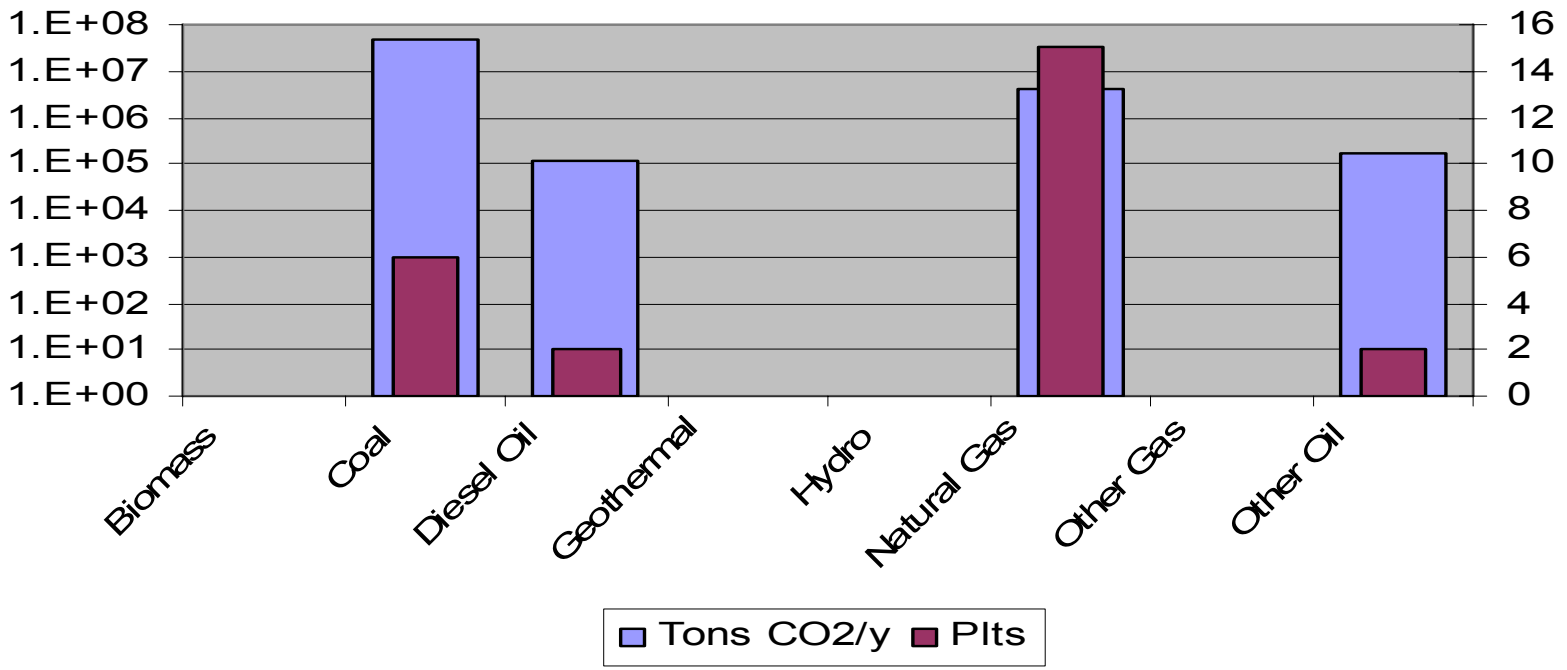
For Each State in Region

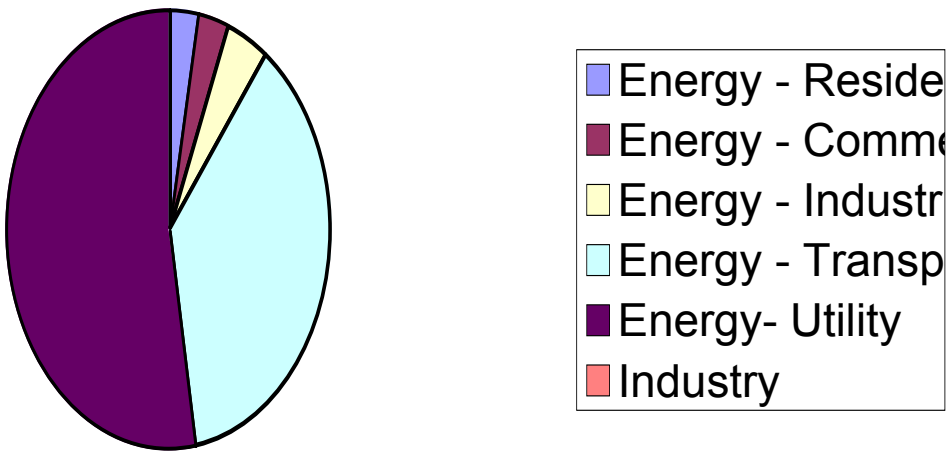
- **CO_2 Emissions by Source**
  - Energy usage
  - Industry (non-energy)
  - Data for 2000
- **Electrical Generation Fuel Type**
  - Tons of CO_2 generated per year
  - Number of plants
  - Data for 2000
- **Number of Plants**
  - Major CO_2 producing industries

ARIZONA

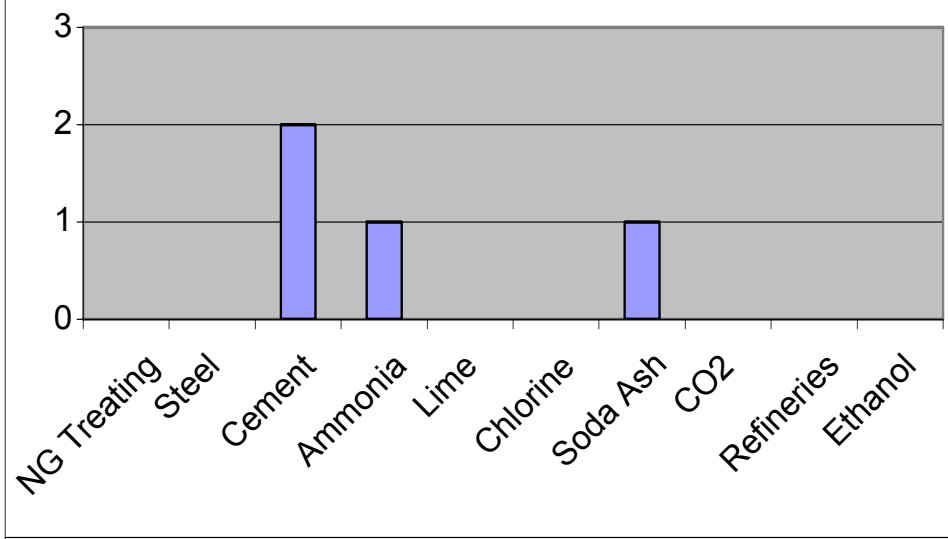
Electrical Generation Fuel Type AZ



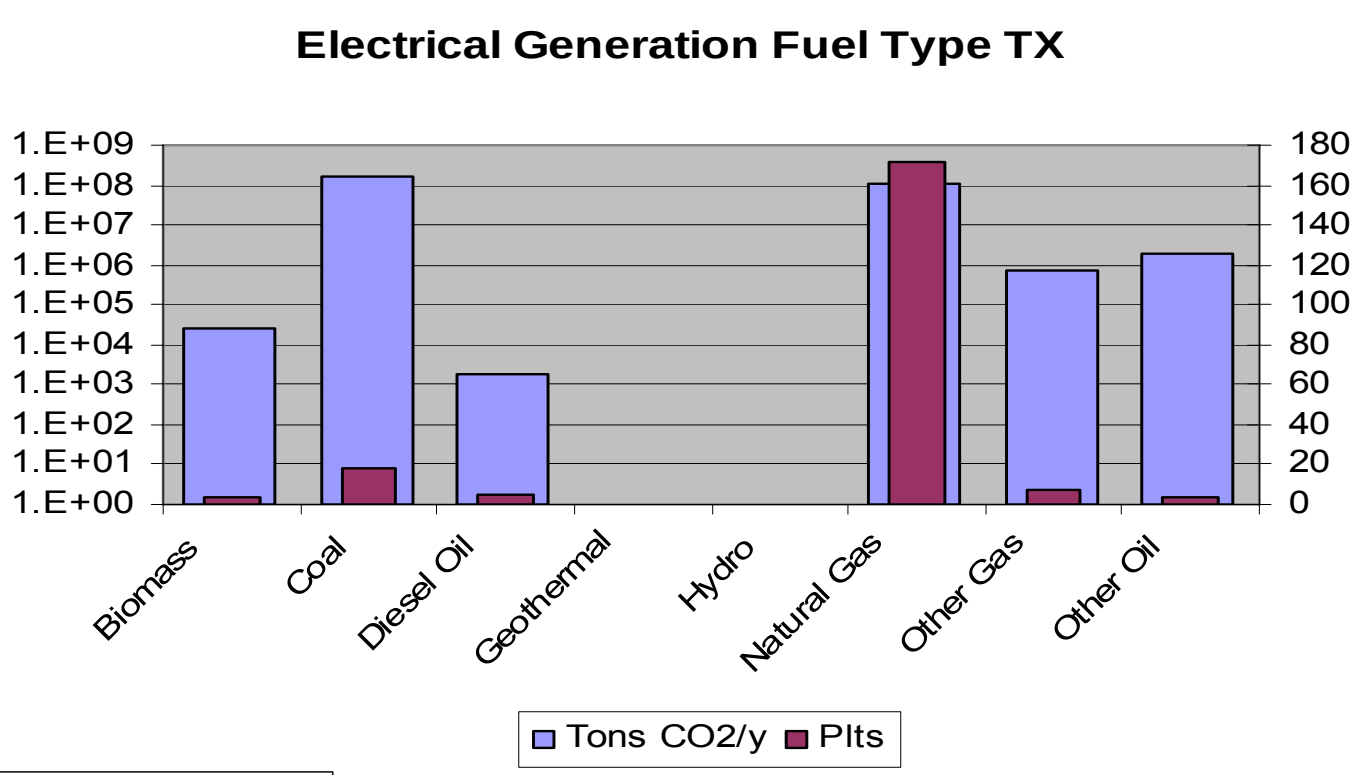
CO2 Emissions*, MM-

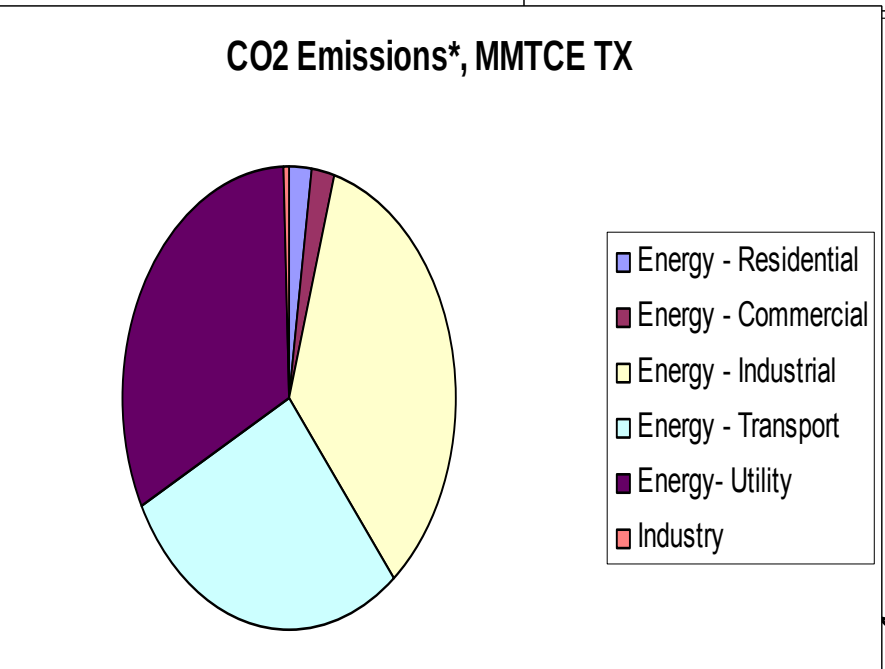


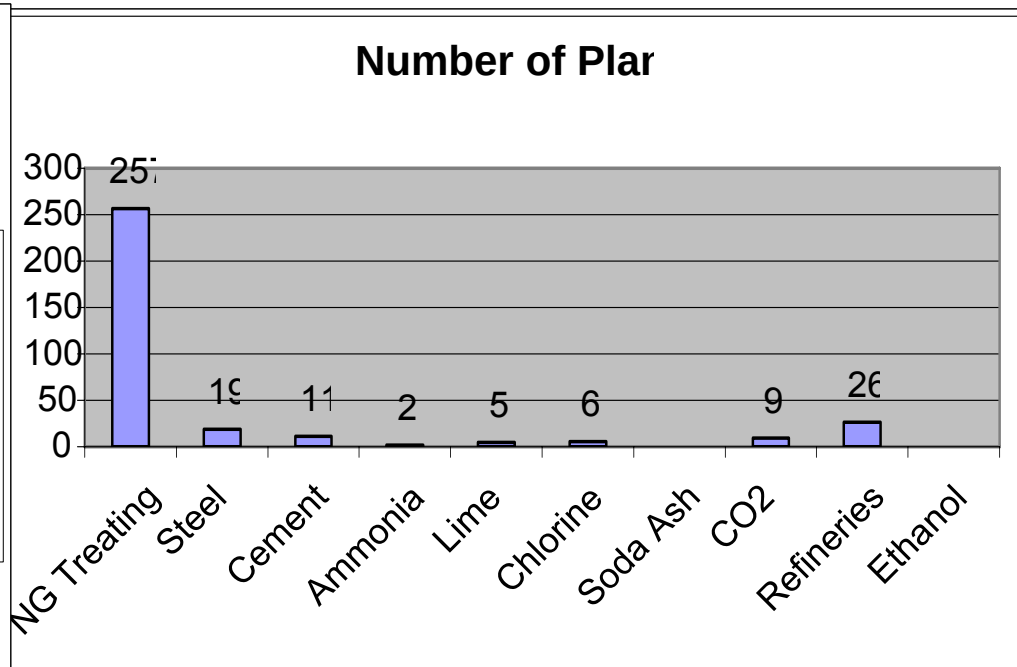
Number of Pla



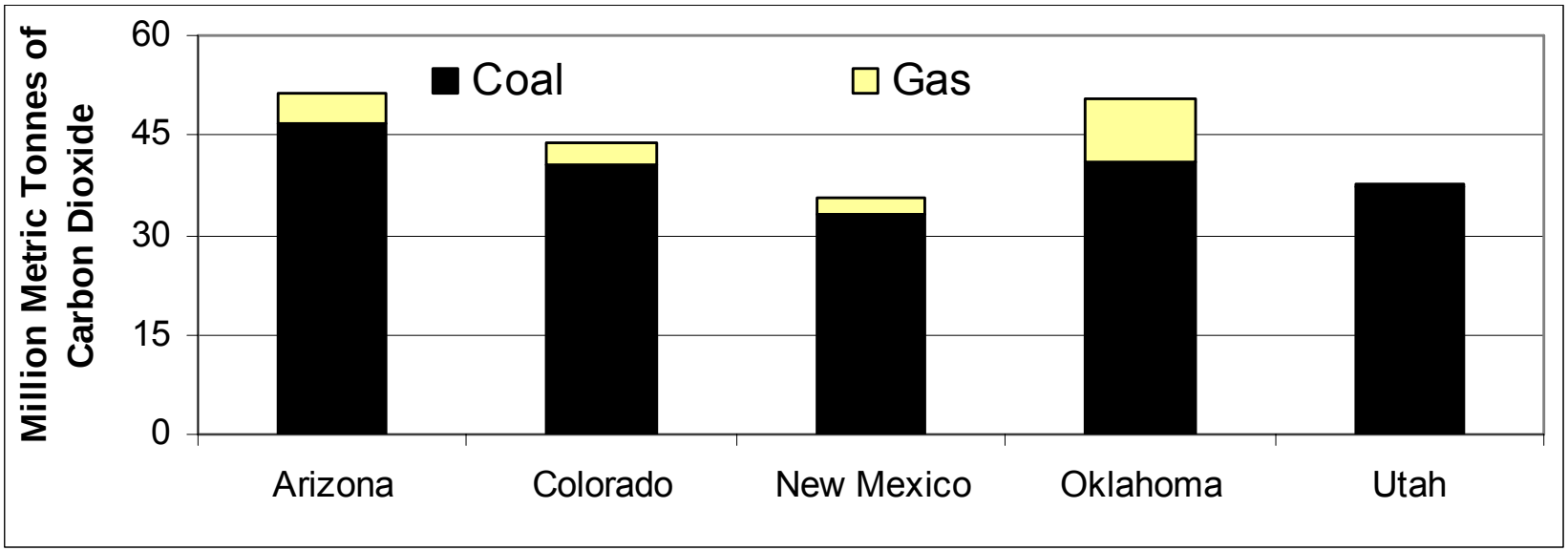
TEXAS


Electrical Generation Fuel Type TX
1.E+09
1.E+08
1.E+07
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
180
160
140
120
100
80
60
40
20
0
Biomass
Coal
Diesel Oil
Geothermal
Hydro
Natural Gas
Other Gas
Other Oil
Tons CO2/y
Plts


CO2 Emissions*, MMTCE TX
Energy - Residential
Energy - Commercial
Energy - Industrial
Energy - Transport
Energy- Utility
Industry


Number of Plar
300
250
200
150
100
50
0
25
19
11
2
5
6
9
26
NG Treating
Steel
Cement
Ammonia
Lime
Chlorine
Soda Ash
CO2
Refineries
Ethanol

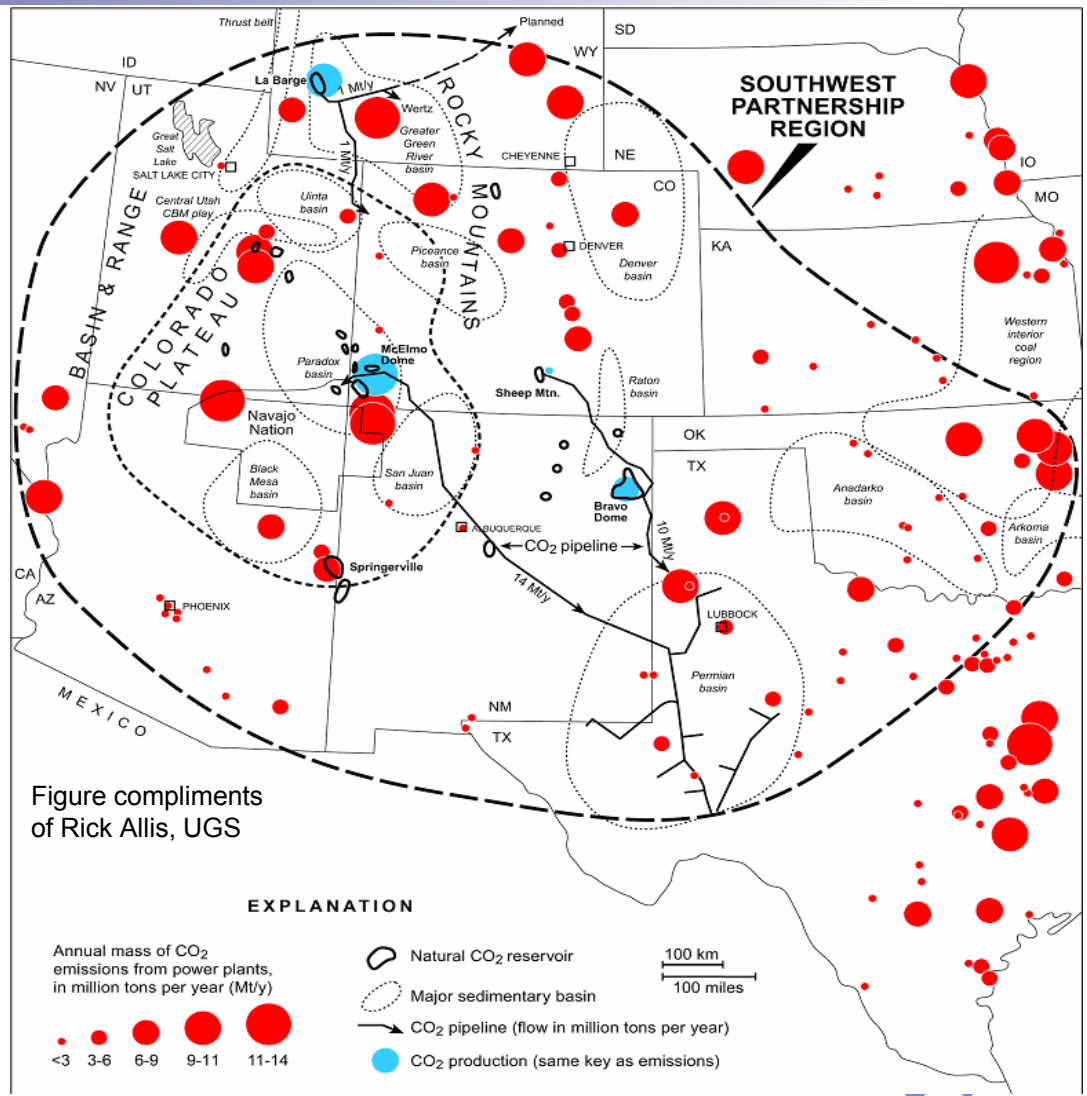
Emissions Summary



General Map of Sources and Pipelines

- *electrical power plants*
- *cement & other processing plants*
- *urban centers*
- *non-point sources (agriculture, automobiles, etc.)*

Total regional point source emissions ~10^8 t/yr.



Emissions and Capture Summary

- **Reviewed capture technologies in use in region**
- **Capture is expensive – C.O.E. may increase 100% for conventional technology (PC plants, MEA)**
- **Emerging technology can reduce the adoption costs for CO_2 capture, but COE still goes up 50%**
- **Incentives, tax credits, emissions trading, technology breakthroughs, additional demonstrations of emerging technology required before CO_2 capture becomes widely employed**

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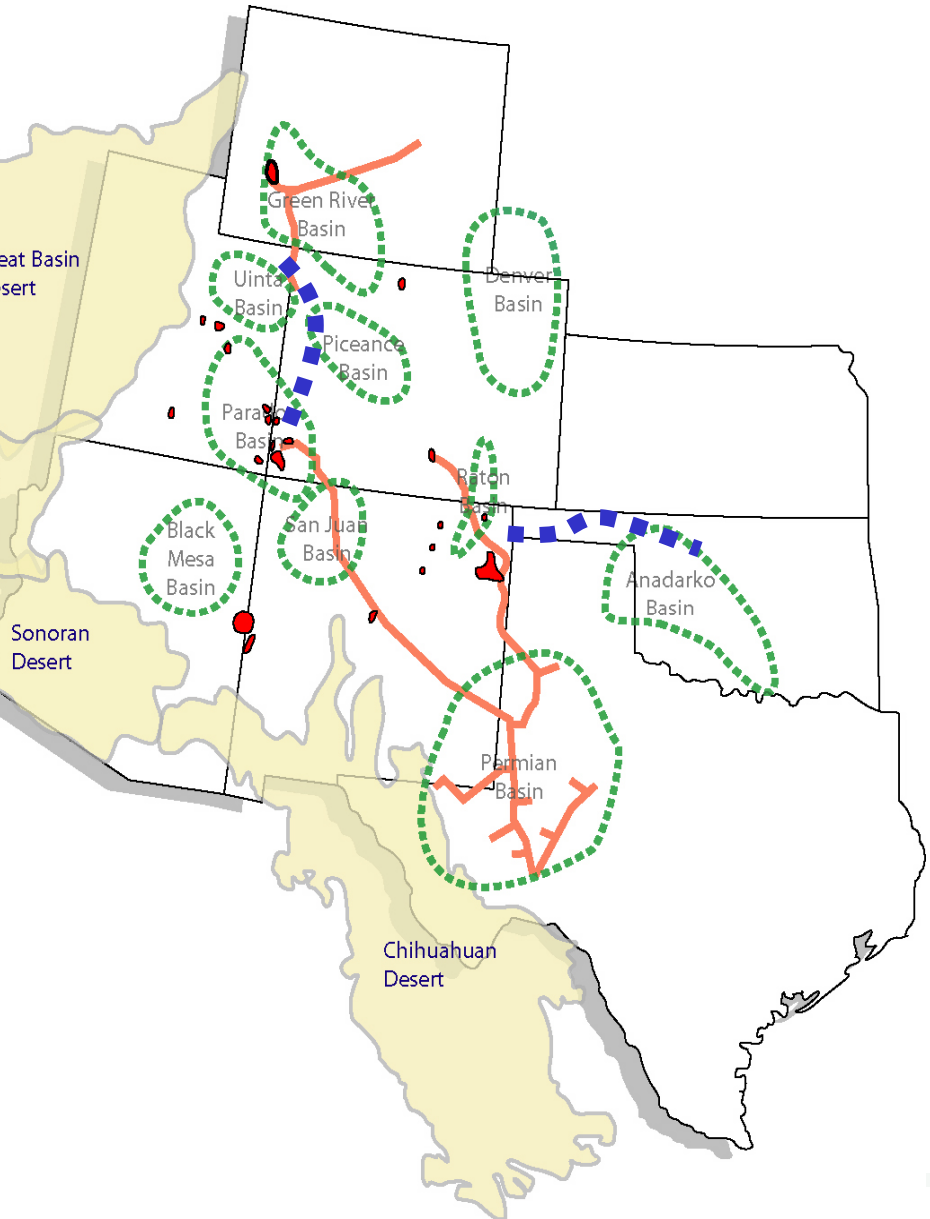
Main Goal: Linking Sources to Sinks

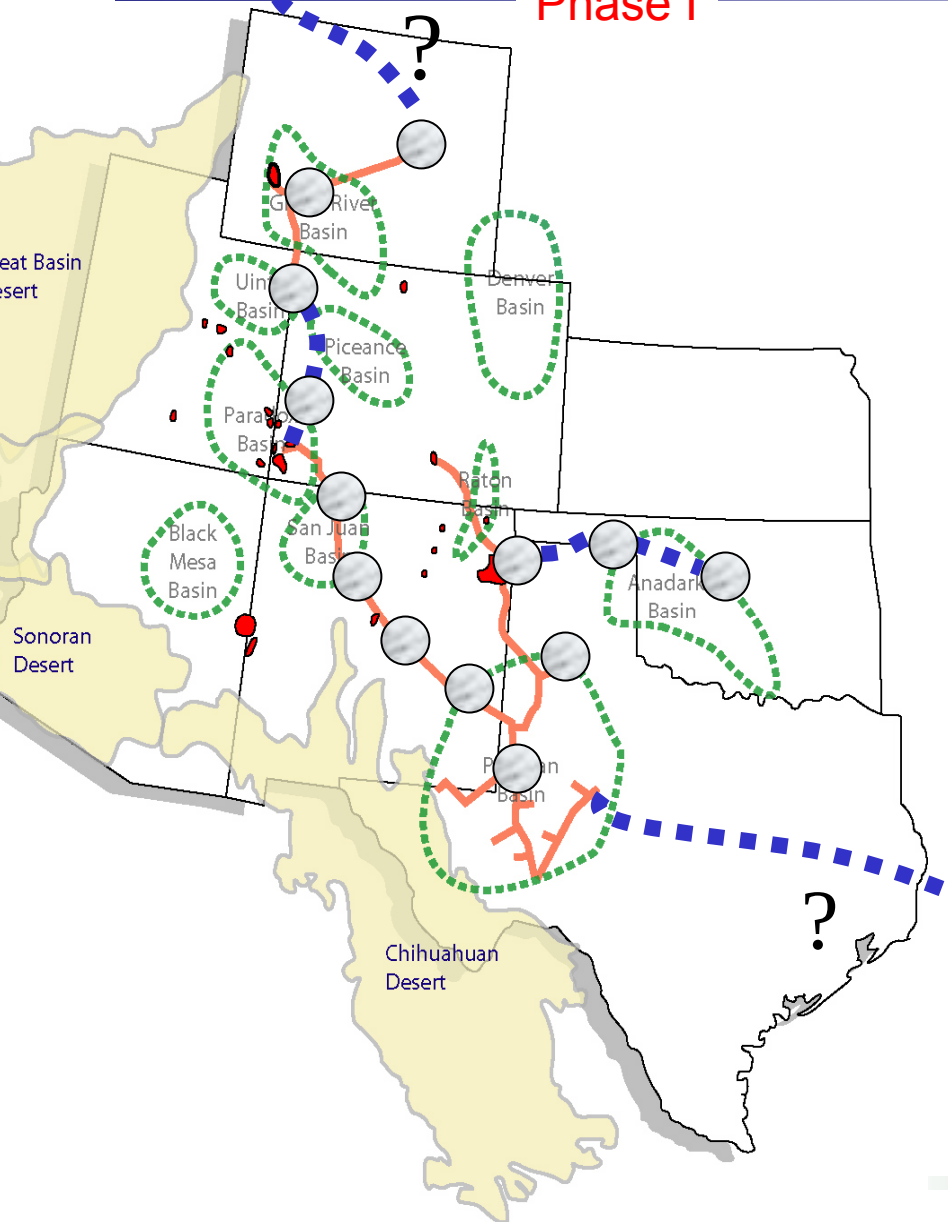


Phase I Primary Tasks:

- Characterize the region's sources and sinks
- Identify the best options by tying sources to sinks
- In the SW: most practical "first opportunities" lie along existing CO_2 pipelines

Regional Characterization → Pilot Demos → Full-Scale Deployment

Phase I | Phase II | Beyond Phase II



Concept:
"String of Pearls"

Pilot demonstrations will test short-term strategy: sequester along pipelines

Integrated Assessment of Sequestration Options

(Ranking the Options in the “String of Pearls”)

- **Main Factors**
  - Sources
  - Proximity of sinks (transportation)
  - Capacity of sinks
  - Viability of sinks (rigorous risk assessment / MMV)
  - Costs / economics (including long-term MMV)
  - Regulatory constraints
  - Public education and approval

Integrated Assessment of Sequestration Options

(Ranking the Options in the “String of Pearls”)

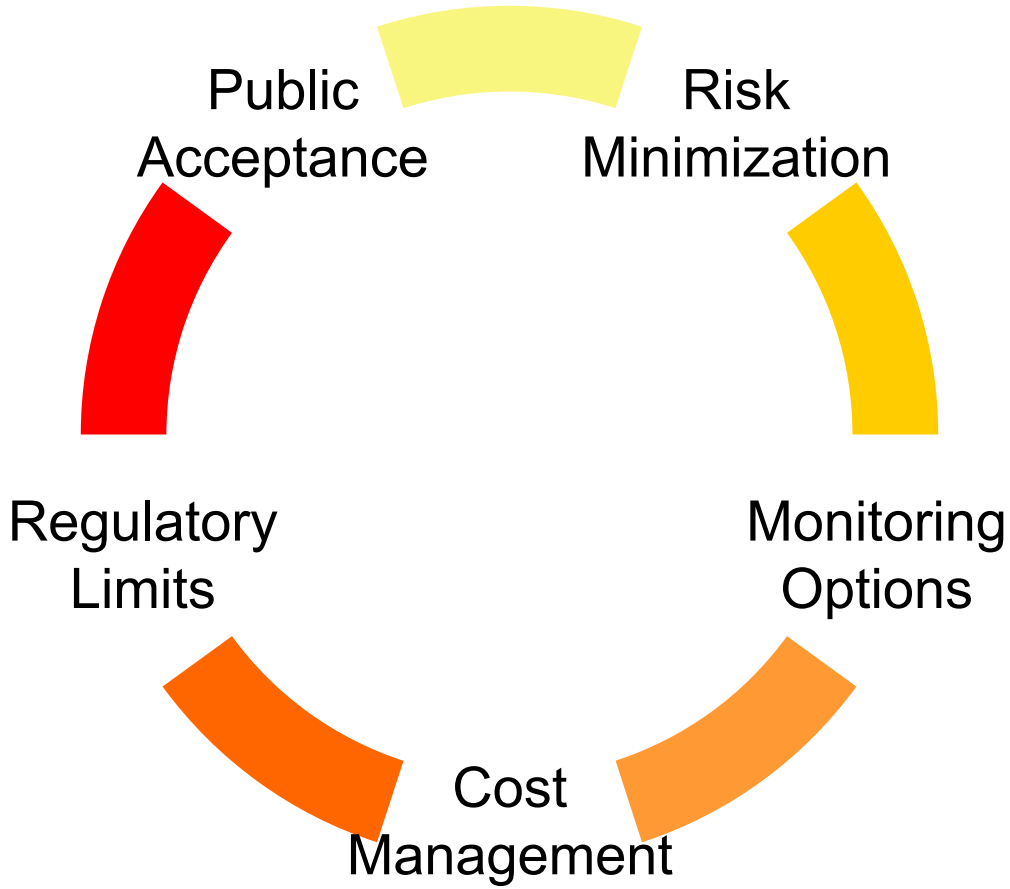
- **Approach: Interactive Tool**
  - Compare quantitatively alternative sequestration technologies in terms of:
    - Costs
    - Environmental risks
    - Monitoring, verification requirements
    - Regulatory, permitting constraints
- **Establish an integrated framework for non-model elements (e.g., non- or semi-quantitative aspects such as public involvement)**

Integrated Assessment Model

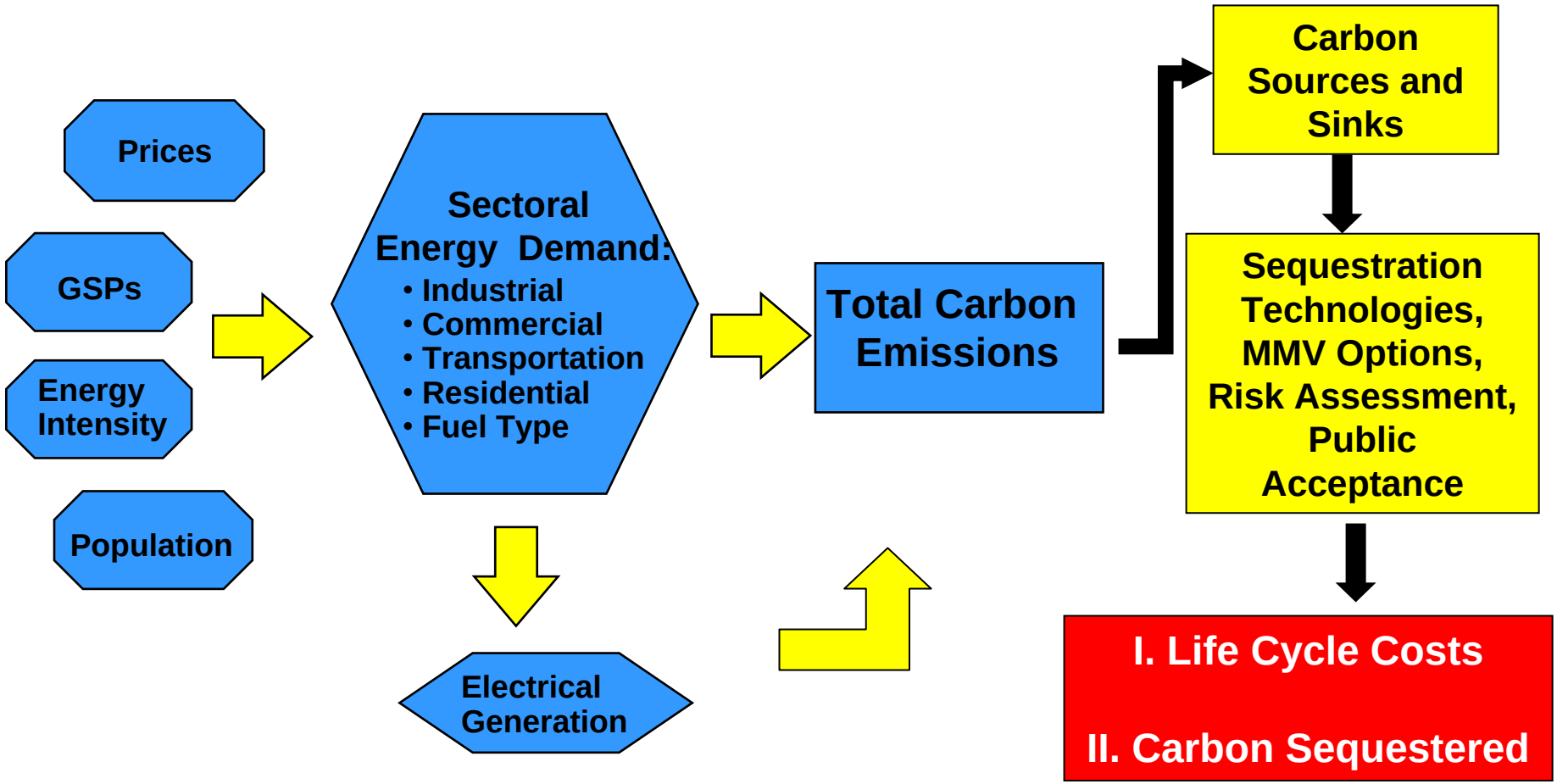
(Ranking the Options in the “String of Pearls”)

- **Dynamic simulation framework**
- **Track annually in southwest region to 2025:**
  - Economic and population growth
  - Energy consumption
  - CO_2 emissions
  - CO_2 sequestration opportunities, potential results
  - Life cycle costs of capture, transportation, sequestration
- **Link GIS database of CO_2 sources and sinks to the economic/population/energy elements**

Other Screening Criteria



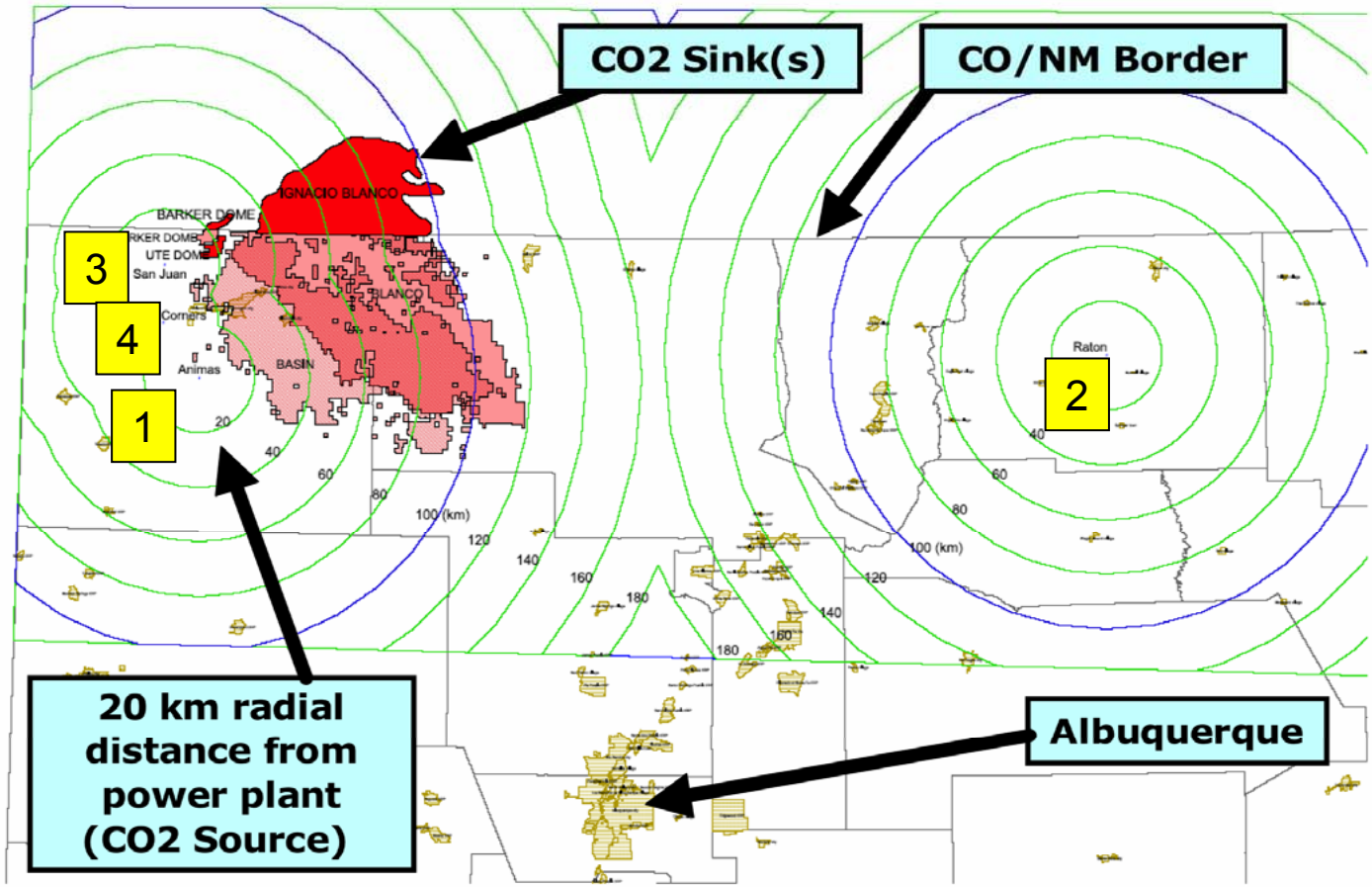
Integrated Assessment Model Summary

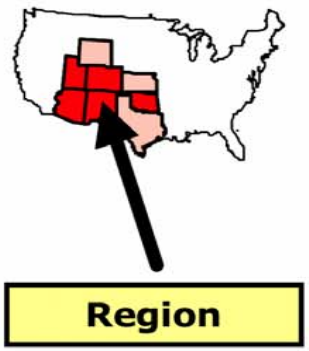


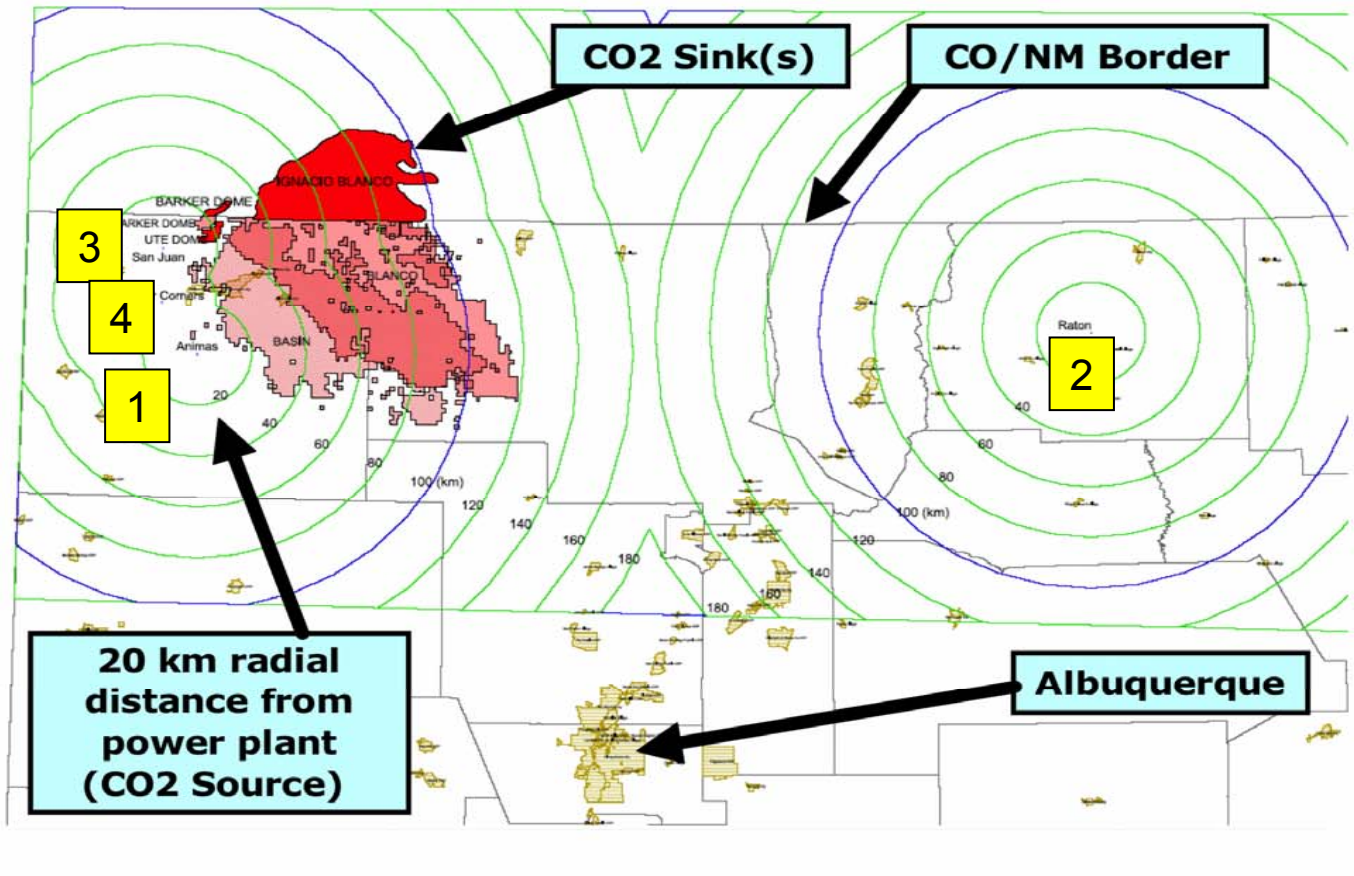
Example of Integrated Assessment Results

Region

1. Animas PP
2. Raton PP
3. San Juan PP
4. Four Corners PP







1. Animas PP
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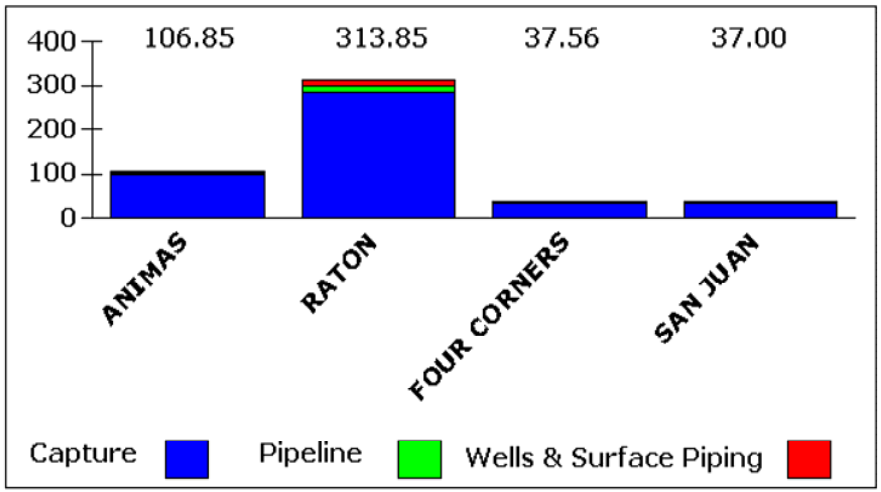
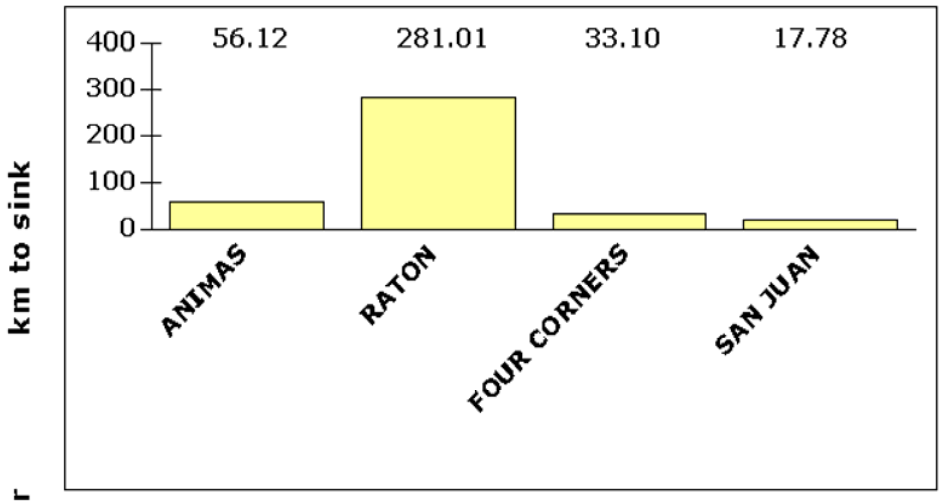
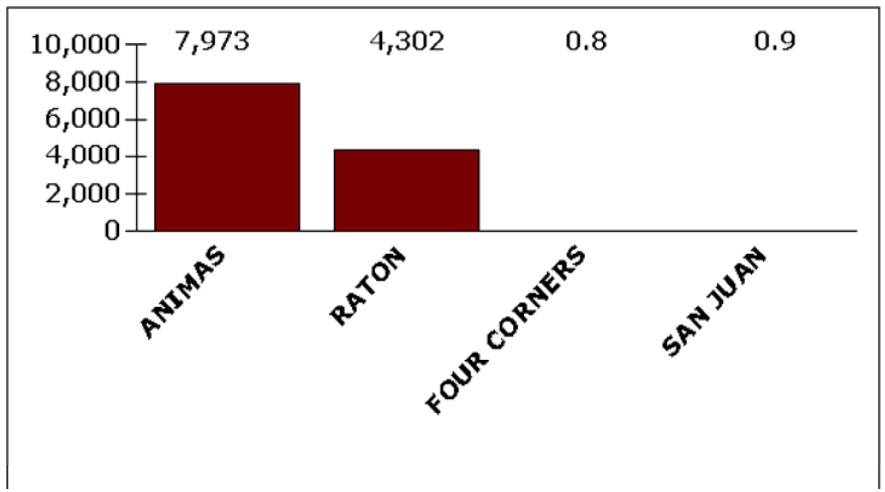
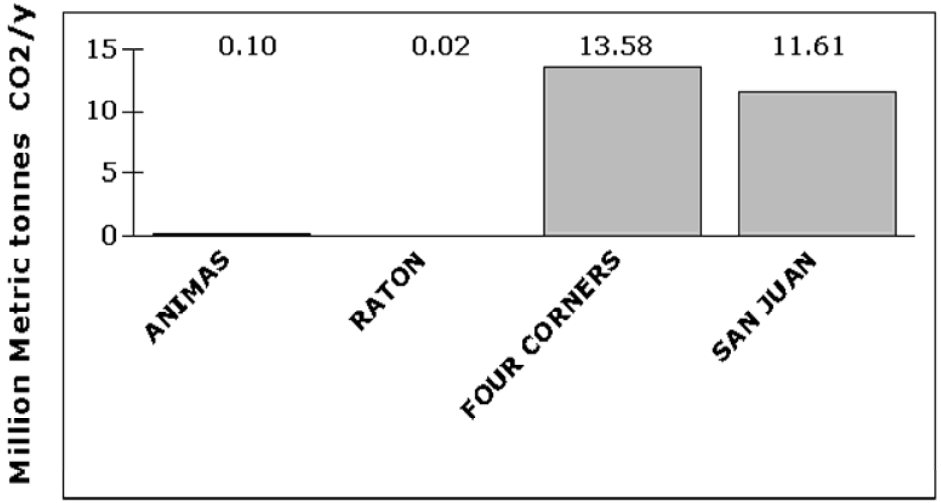
⇨ **Evaluate sources (the 4 plants) with respect to potential sinks (red)…**

Example of Integrated Assessment Results









Only one depleted gas reservoir considered; lifetimes increase when ECBM and saline reservoirs also considered

Phase I Summary

- regional sources and sinks characterized (ongoing)
- capture technologies in region explored
- public acceptance evaluated (ongoing)
- integrated analysis of sources, viable sinks, economics (costs), risks, regulatory aspects provided ranking of options for Southwestern U.S. (ongoing)
- suggested first options for testing: along pipelines -- “String of Pearls” approach

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